



Denver Water

Operations & Maintenance Division

Standard Operating Procedure

Subject : Clear water storage basins

Item : Emergency maintenance

Date : November 15, 1999

Revision Date:

Purpose

- A. To establish guidelines for the inspection, maintenance, cleaning and disinfection of clear water storage reservoirs in the Denver Water distribution system when a situation arises requiring an emergency outage of the facility.
 - 1. Such outages include, but are not exclusive to:
 - a. Water quality deterioration.
 - b. Suspected or real breaches of the facilities security measures that indicate the reservoir may have been entered by unknown parties.
 - c. Signs of damages to the facility by animals, weather or earth movement such as quakes or mud slides, that may have allowed contamination to enter.
- B. To establish safety procedures which will provide adequate protection for workers and the public.

Policy

- A. It shall be the policy of Denver Water to conduct systematic inspections on a daily basis of all clear water storage reservoirs in the water distribution system in order to quickly detect situations that may require an immediate emergency outage followed by proper maintenance and a thorough cleaning and disinfection
- B. It shall be the policy of Denver Water to conduct a water quality monitoring program that will detect water quality deterioration.
 - 1. This program must monitor such factors as:
 - a. Chlorine residuals
 - b. Turbidity
 - c. pH levels
 - d. Nitrates
 - e. Heterotrophic plate counts

Quality thresholds

- A. Chlorine residuals should be monitored and at least two levels of action taken.
 - 1. With residual level reading of .5 mg/l operator should notify supervisors, and begin to fluctuate water levels or increase pumping through a facility to increase flows.

2. When tested water shows a residual of .2 mg/l the reservoir should be isolated and cleaned. If operational considerations require that the reservoir be placed back in service it must be thoroughly disinfected.
- A. Heterotrophic plate counts (HPC) samples must be taken and cultured in a qualified laboratory on a routine basis.
 1. HPC action levels are:
 - a. At 400 CFU/ml, the operator must notify supervisors, fluctuate water levels and/or increase pumping through a facility to raise flows.
 - b. At 500 CFU/ml, the reservoir should be isolated and cleaned. If operational considerations require that the reservoir be placed back in service it must be thoroughly disinfected.
- B. It is essential to monitor pH levels in a storage reservoir. High pH readings often point to chlorine residual problems.
 1. New concrete surfaces can contribute to the problem.
- C. Sedimentation inside a storage reservoir will also affect quality testing levels as well as visual and taste characteristics. Cleaning is the only remedy.
- D. Contaminant entry can be a factor in water degradation. Plants, birds, small animals or wind blown dirt are most common. A close inspection should reveal where entry has been made to the reservoir. Repair with A.W.W.A. approved methods and products followed by cleaning and disinfection are required.
- E. Nitrate levels should be routinely tested.
 1. Loss of chlorine residuals or an increase in water temperature are the most common cause.

Equipment

- A. Testing equipment for chlorine residuals and good quality thermometers for monitoring water temperatures are required.
- B. Workers must be provided with personal safety equipment i.e. hard hat, traffic safety vest, toe protection. Further equipment needed for disinfection are lung, eye and skin protection.
- C. Reservoirs must be supplied with wash water supply systems sized adequately to insure all debris can be flushed thoroughly to floor drains.
- D. Clean hoses used only for the purpose of reservoir cleaning are required.

Procedure for draining

- A. Draining operations must be reported to the proper authorities predetermined for each facility.
 1. This includes CDPHE, local governments, internal quality control personnel and drainage districts.
- B. Total gallons to be drained, flow estimates and duration of draining must be reported.
- C. Outflow must be periodically checked to prevent property damage.
- D. Cleaning and / or disinfection crews must be given ample notice to prevent delays in returning the facility to normal use.

Procedure for reservoir maintenance

- A. Close inspection of all surfaces inside a storage facility must be conducted.
 - 1. This includes stairs or ladders.
- B. Repairs to any rough surface that may collect debris must be made.
- C. All hoses used for cleaning must be inspected and found to be clean and to have not been used for any other purpose.
- D. An inspection of entry doors or hatches must be conducted to insure all close and seal tightly.
- E. Bug screens must be inspected for proper fit and general integrity.
- F. Support structures such as foundations and pillars should be inspected for signs of movement or deterioration.
- G. Signs of corrosion should be located and repaired.
- H. Site drainage should be evaluated and any pooling of rain water or runoff collection around a reservoir should be prevented.
- I. Signs of leakage point to areas in need of repair.
- J. Records of necessary repairs and actions taken must be maintained for the life of a given facility.

Procedure for cleaning

- A. Basic cleaning is generally done with a high pressure water wash while areas with more stubborn surface buildup must be scrubbed with heavy brooms or brushes.
- B. Loose guard railings, concrete scaling, concrete pitting etc. are examples of situations where debris may collect or bacteria may grow.
- C. Chronic quality problems may be remedied with the design and proper placement of baffles or flow diverter which have the effect of enhancing the circulation of water within a storage reservoir.
- D. Sealing of even the smallest cracks in roofs, or area where walls and roofs meet is required.
- E. Cathodic protection to exposed metal surfaces will help prevent rust, discoloration of stored water and prevent increased iron levels.
- D. Testing of valves which are not accessible under normal operational circumstances should be conducted. Repairs or replacements should be done at this time.

Procedure for disinfection

- A. All workers must be equipped with eye, lung and skin protection.
- B. A qualified person must determine the amount of chlorine needed for proper disinfection.
- C. All surfaces – walls, ceilings, ladder and floors must be disinfected.
- D. No entry is allowed after a reservoir has been disinfected.
- E. Early notification of an operations crew should be made in order to return the reservoir to service in a timely manner.

Procedure return to service

- A. All valves relating to a clear water storage reservoir should be clearly marked to prevent operational mistakes which may contaminate a clean basin.
- B. Storage facilities should be provided with a site specific map which clearly illustrates valves and piping.
- C. Only experienced personnel should make operational decisions.
- D. Once a reservoir has been cleaned & disinfected, it should be filled with only clean, high quality water.
 - 1. For example, water from a second uncleaned basin must not be allowed to fill a newly cleaned reservoir.

Operation procedures

- A. Water system operators must fluctuate water levels within a storage reservoir as much as prudently possible based upon testing results.
- B. Planning concerning pumping schedules with the maintenance of water quality in mind is essential.
- C. Daily consideration of water quality sample test results assist in operational decisions.
 - 1. The best tool for maintaining high quality water in a storage reservoir is early detection or spotting trends that point to deterioration of the product.
- D. Daily facility inspections by experience personnel will detect vandalism or breaches of security such as open or missing locks, open hatches and signs of animal burrowing or bird nesting.
 - 1. A buildup of animal waste or nesting material may point to a location where an opening may exist.
- E. Perimeter fences and gates should be inspected daily to detect unauthorized entry to the vicinity of the storage reservoir. Again, early detection can prevent vandalism that may take place and/or escalate over several days.